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Publication date:
2008

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Rathmann, O., Mann, J., Dellwik, E., & Bingöl, F. (2008). *Wind profile measurements over a forest with lidar*. Abstract from 2008 European Wind Energy Conference and Exhibition, Brussels, Belgium.
http://www.risoe.dk/rispubl/art/2008_63.pdf

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Session: Site assessment (CS4.4)

Track: Scientific

WIND PROFILE MEASUREMENTS OVER A FOREST WITH LIDAR (abstract-ID: 340)

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It is estimated that 30% of the European wind energy growth takes place in areas where the wind flow is affected by forests. The description of the wind conditions near and above forests poses a challenge, since assumptions of classical boundary-layer theory are violated. We investigate the mean wind profile and turbulence statistics above a dense beech forest by use of a laser Doppler anemometer. The aim is to quantify properties of the atmospheric flow over a forest relevant for loads on wind turbines and to compare them to models.

Experiment : The experiment has taken place at Sorø site which is located in an 85 year old beech forest called Lille Bøgeskov on the island Zealand, Denmark. The 57m tall mast is located in the middle of the forest. The beech trees are on average 25m tall. Next to the mast there is a 24m tall scaffolding tower, where the QinetiQ ZephIR Doppler LiDAR was placed at the level of the tree tops. Wind measurements in the mast consist of cup/sonic anemometers and vanes up to 57m. We use the prototype version of QinetiQ's ZephIR LiDAR in conical mode [1] to measure the winds up to between 48 and 175 m and in horizontal mode [2] looking upwind from 5 to 60m in horizontal focus distances.

Results: Half hour periods as functions of direction show that the wind speed increases with height and the wind directions are seen to turn slightly clockwise as height increases for most of the half hour runs. This is qualitatively what should be expected from the Ekman turning. It would be difficult, if not impossible, to align ordinary vanes in a mast to measure the same, and it is something that can be compared with model calculations, if these include the Coriolis force. The momentum fluxes have been calculated are nearly 20% higher than what has been calculated with sonic anemometers. In order to examine the homogeneity of the flow over the canopy the LiDAR was moved from tower to the met. mast and mounted at 30m and 42m heights while looking upwind. A homogenous horizontal profile has been observed as it was expected.

Conclusion: We can measure profiles with a LiDAR both of the mean wind speed, the wind direction, and, with more uncertainty, the momentum flux in vertical scanning mode and simple horizontal profile looking upwind. Interesting work remains to be done on the ways to analyze the LiDAR data. The comparison with the SCADIS [3] model are very encouraging. Especially the mean wind and direction profiles are predicted well.

[1] Smith D A, Harris M, Coffey A S, Mikkelsen T, Jørgensen H E, Mann J & Danielian R 2006 Wind Energy 9(1-2), 87-93.

[2] Bingöl F., Mann J. and Larsen G.C, 2007 EWEC

[3] Sogachev A, Leclerc M Y, Karipot A, Zhang G & Vesala T 2005 Agricultural and Forest Met. 133(1-4), 182-196.
